08.01_PH-SUMMER SCHOOL

HEATING AND DOMESTIC HOT WATER

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CONTENT OF THIS PRESENTATION:

This presentation is based on “PHS 1.0 Passivhaus Schulungsunterlagen 6.3.5” from Donauuniversität Krems and Energieinstitut Vorarlberg, a „Building of Tomorrow“- project supported by the Austrian Federal Ministry for Transport, Innovation and Technology.

Heating and the Passive House Standard

A Passive House is very often character-ised as a house without heating (need). This is not correct. A Passive Houses has still a heating need – but a very small one!

The calculation to derive the “Condition for Passive Houses" is:

300W/Pers. / 30m³ living space /Person = 10W /m² living space

Source:

That means all the heating supply can brought in by the comfort / hygienic ventilation volume.

The strategy to reach this is:

- Don't loose heat by transmission
- Recycle heat of ventilation
- Use solar heat gains
- Use of internal gains

Source:

Heating and the Passive House Standard

The best heating method of a PH is a house-warming party !

Much people per m² - High internal gains

House-warming party of the Krumke-family, 2007-02-23

Source: http://optimierung.mathematik.uni-kl.de/~krumke/baublog/2007/02/

Heating and the Passive House Standard

This picture shows the requirement of the heating system for the heat supply of a Passive House!

max. Heating load < 10 W/m2

Example:
15 m² child's room
needs
150 W heating load in the coldest night:
That represents the power of 5 candles

30 m² = 10 candles
60 m² = 20 candles
90 m² = 30 candles
120 m² = 40 candles
150 m² = 50 candles

Passive Houses – Houses without heating?
Fortunately not!
But very less and only on cold days!

Source: M. Ploss

Heating without a Separate Heat Supply System

The heating demand in a Passive House is so low that a separate heat supply system is not necessary. The heat input can be done with the ventilation system. The controlled ventilation system is necessary by hygienic requirement.

The distributable heat quantity from the ventilation system results from the following limiting factors:

1. **Hygienic conditions: Supply air: V ~ 1m³/(h*m² living area) for approximately 30m² living area / person area**
2. **Temperature limit: < 50°C in the heater (avoidance of dust toasting)**
3. **Temperature difference: outside –10°C, inside +20°C = 30K**
4. **Heat capacity of air: 0.33 Wh/(Km³)**

The max. heating load is calculated as follows:

1m³/(hm²)*0,33Wh/(Km³)*30K = 10W/m² living area

For normal Central European climates this results in an annual heating demand of max. 15 kWh/(m²*living area*a)

Source: Energieinstitut Vorarlberg

Significance and requirements of heat production in PH

- Extremely low heating demand
  - Heating demand ≤ 15 kWh/(m²a)
  - Approximate factor of 4 to 6 times lower than for new buildings with minimum heat protection
- Dominance of the hot-water heat need
  - Hot-water heat need ~ 15 to 30 kWh/(m²a)
  - In principle independent of the heat protection standard
- Heating in the room
  - Conventional heaters are limited in their usefulness due to their excessive heating performance in a PH
  - Heating places must absolutely be operated independently of room air
- Combined room and hot-water heat production
  - In view of the equivalence of the room heat and need for hot-water, a composite warmth production must be striven for

Source: PHS 1.0 Passivhaus Schulungsunterlagen 6.1.1

Significance and requirements of heat production in PH

- Usual variety of heat production
  - In principle, all well-known heat producers can be used.
- Cost-effective, passive house-specific special form: The compact unit
  - Only in the PH is the cost-effective heating and hot-water production with a heat-pump compact unit useable.
- Heating in the room
  - Conventional heaters are limited in their usefulness due to their excessive heating performance in a PH
  - Heating places absolutely must be operated independently of room air
- Combined room and hot-water heat production
  - In view of the equivalence of the room heat and need for hot-water, a composite warmth production must be striven for.

Source: PHS 1.0 Passivhaus Schulungsunterlagen 6.1.2

Unusual features of the heat production in passive houses

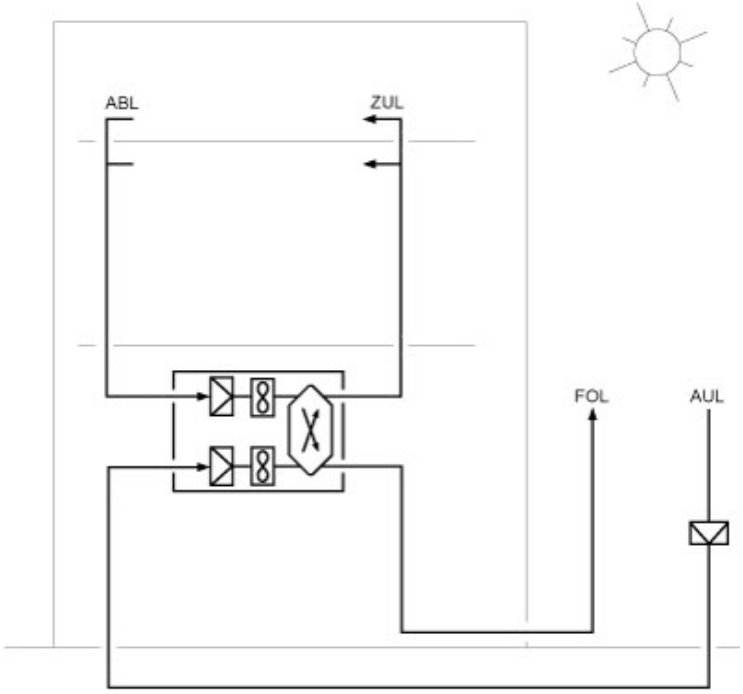
- First season, Heating dry
  - Heating up the building mass and heating dry can double the heat demand in the first heating season
- Temporary temperature variations
  - Lowering the temperatures at night in the passive house is not useful or necessary
  - Long-term temperature reductions have to be avoided. They bring a drastically increased short-term heating power demand
- Building mistakes can't be “heated out“
  - Mistakes in the construction can't be compensated for from a right dimensioned heating system.

Source: PHS 1.0 Passivhaus Schulungsunterlagen 6.1.3

Exemplary solutions for heat production

System 1, the basic passive house technology

Heat exchange unit (with EHE) for room pre-heating



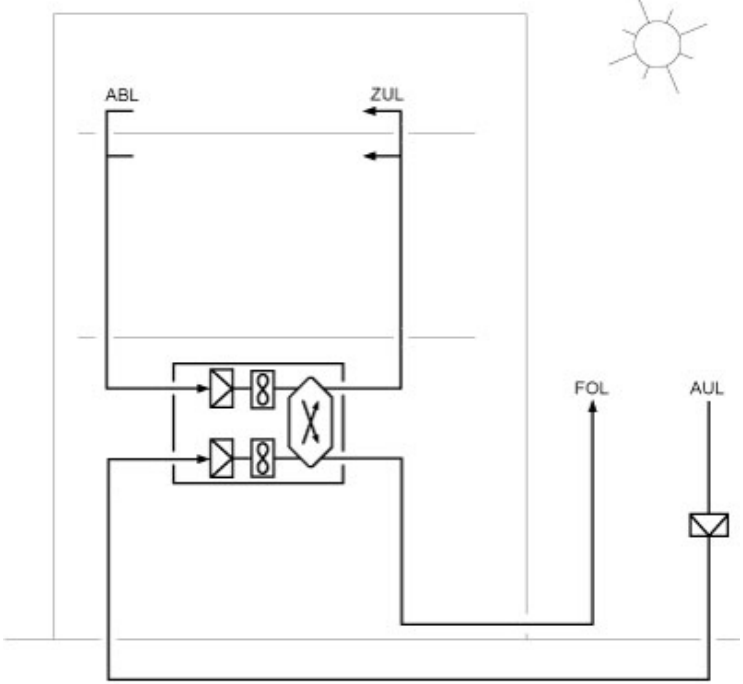
- The required fresh air quantity is preheated over an earth heat exchanger on 4 to 10°C.
- By the heat exchanger the fresh air is warmed nearly to room temperature.
- The exhausted air cools down to 5 - 10° C.

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 1, the basic passive house technology

Heat exchange unit (with EHE) for room pre-heating



Components:

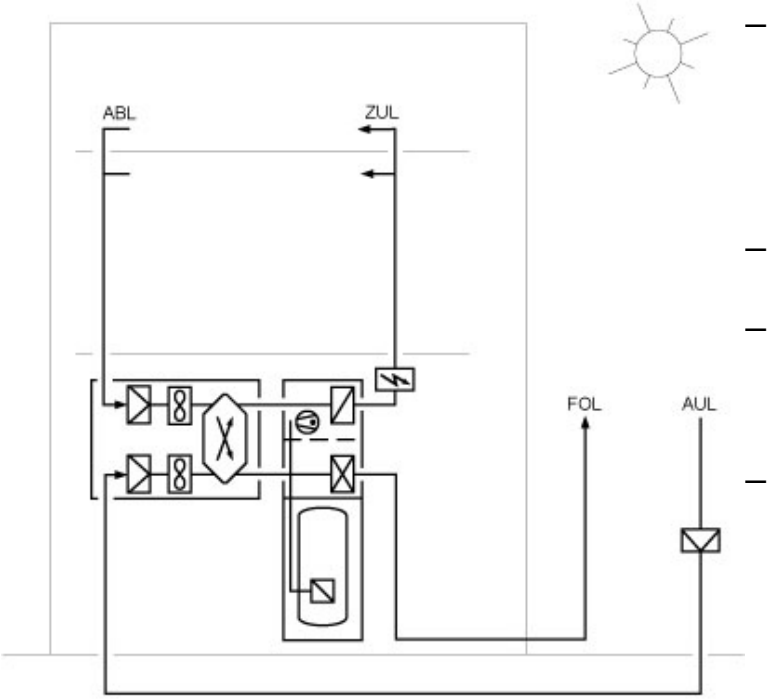
- air filter
- ventilators
- ventilation heat exchanger
- earth heat exchanger

Source:

Exemplary solutions for heat production

System 2, the classic passive house technology

Compact unit (with EHE) for room heating and hot-water



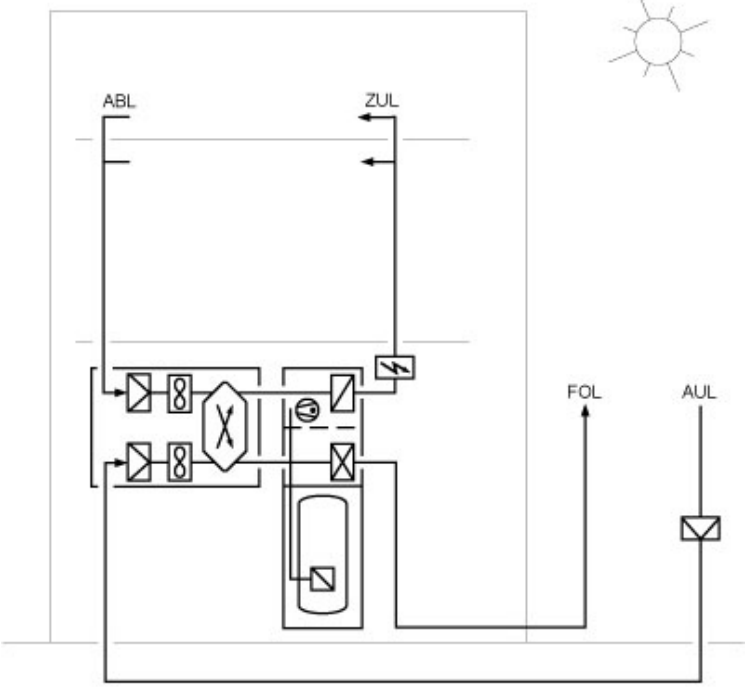
- Further heath still can be extracted from the exhausted air now with a very efficient small heat pump. This cools the exhausted air down on up to -5°C and supplies the warm water or the input air with this energy.
- For a peak load is a small additional electrical heating in the input air tube.
- In the end it remains an electrical current demand from 1000 to 2000 kWh/a (depending on building size and building standard).
- A modest Photovoltaic system already can deliver a large part of this necessary energy!

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 2, the classic passive house technology

Compact unit (with EHE) for room heating and hot-water



Components:

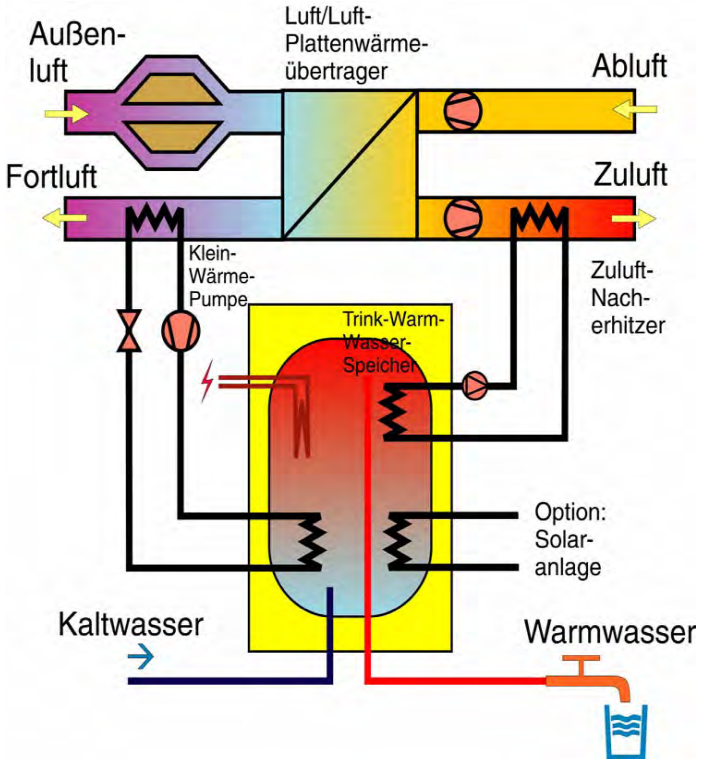
- air filter
- ventilators
- ventilation heat exchanger
- earth heat exchanger
- air/ water heat pump in output air
- warm water storage tank
- warm water-heating register for input air

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 2, the classic passive house technology

Compact unit (with EHE) for room heating and hot-water



Components:

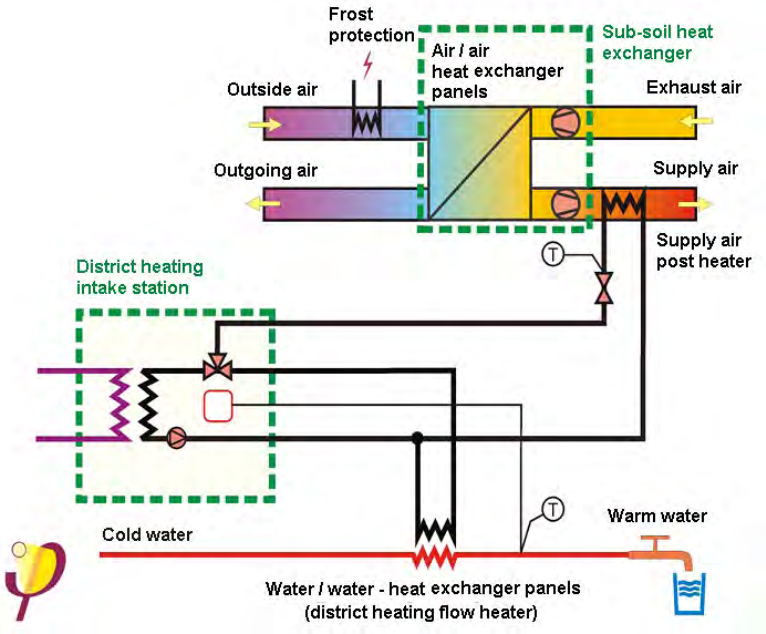
- air filter
- ventilators
- ventilation heat exchanger
- earth heat exchanger
- air/ water heat pump in output air
- warm water storage tank
- warm water-heating register for input air

Source: PHI

Exemplary solutions for heat production

System 2, the classic passive house technology

Compact unit for room heating and hot-water



Components:

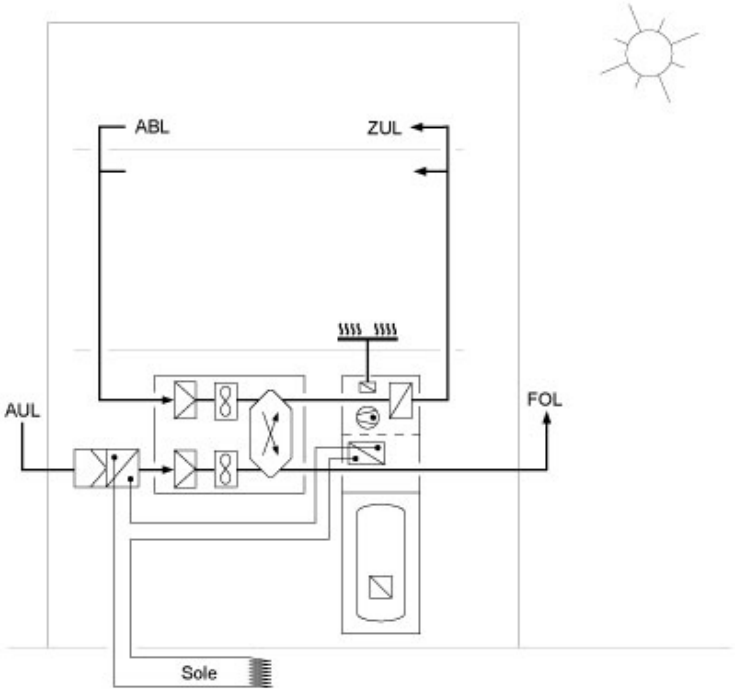
- air filter
- ventilators
- ventilation heat exchanger
- district heating heat exchanger
- warm water-heating register for input air
- water/water heat exchanger (flow heater)

Source: PHI

Exemplary solutions for heat production

System 3, passive house technology extent

Compact unit (with EHE) and combination with low-temperature heating



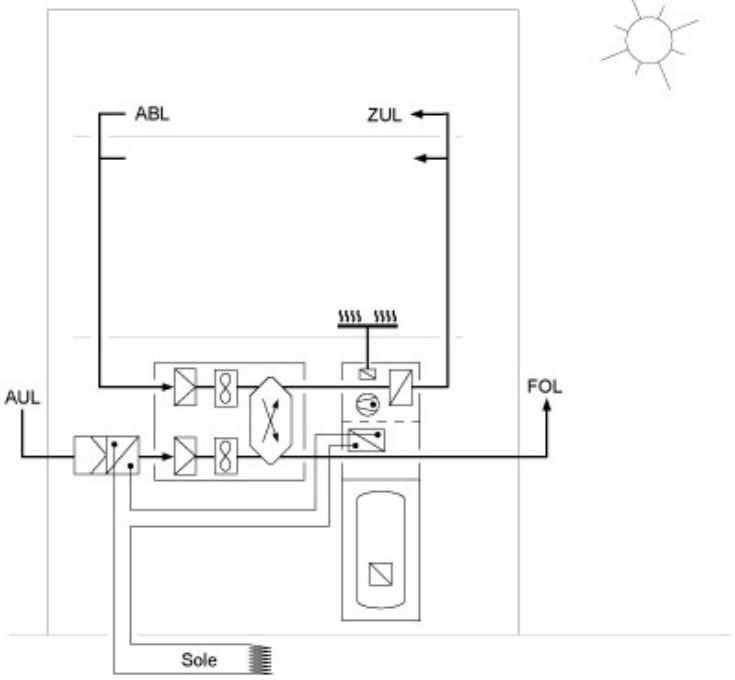
– An additional plastic pipe buried in the earth supplies geothermal power to the compact unit, which can increase its output to about 3 kW. Brine is used as the medium for the transfer of geothermal energy. About a third of the heat transfer takes place over the supply air and two thirds over an optional low-temperature heating circuit.

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 3, passive house technology extent

Compact unit (with EHE) and combination with low-temperature heating



Components:

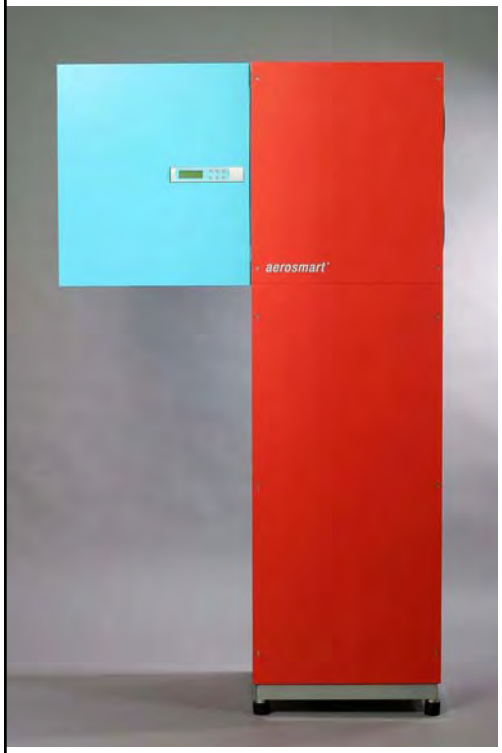
- air filter
- ventilators
- ventilation heat exchanger
- earth heat exchanger with brine pipes
- water/water heat pump
- warm water storage tank
- warm water-heating radiator for input air
- low temperature heating (radiator, …)

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 3, passive house technology extent

Compact unit (with EHE) and combination with low-temperature heating



Passive house – compact aggregate – complete domestic services on 1m²

– takes very little floor space (1 - 2 m²) for heating, warm water and ventilation

– actually 8 to 10 manufacturers, an Austrian world market leader

– numerous variants

– power tests at Fraunhofer- Institute ISE, Freiburg (Germany)

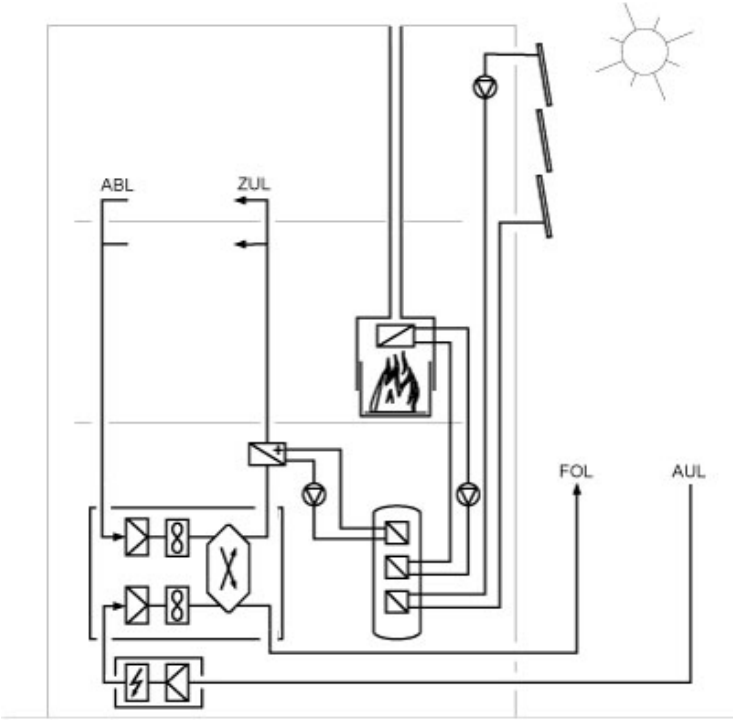
– good combination possibilities with thermal solar systems and / or PV-systems

Source:

Exemplary solutions for heat production

System 4, passive house technology and biomass

Heat exchange unit (with EHE) with pellet oven or wood stove



– Based on the operation of passive house technology, a pellet-, woodchip- or also even a bio-alcohol oven is used here for peak-load covering.

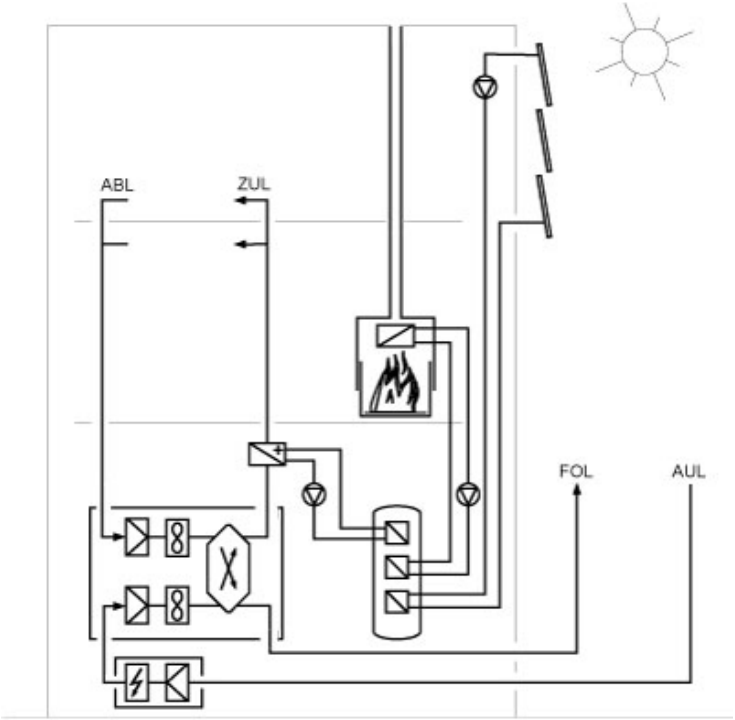
With this design, buildings are given a heating energy characteristic number of about 30 kWh/m²a. The need for precious electrical power remains low. The peak load is renewable with pellets or woodchips.

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 4, passive house technology and biomass

Heat exchange unit (with EHE) with pellet oven or wood stove



Components:

- air filter
- ventilators
- ventilation heat exchanger
- warm water storage tank
- wood stove with water circulation pipe to warm water storage tank
- solar panel with water circulation pipe to warm water storage tank
- warm water-heating radiator for input air

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 4, passive house technology and biomass

Heat exchange unit (with EHE) and combination of wood-stove with water heat exchanger

Wodke "Momo"

Requirements:

- **Adapted performance**
- **little heat output to site room**
- **high heat output to the buffer store**
- **combustion air independent of room air**

Source: Energieinstitut Vorarlberg

Exemplary solutions for heat production

System 4, passive house technology and biomass

Heat exchange unit (with EHE) and combination of

wood-stove with water heat exchanger

Requirements:

- **Adapted performance**
- **little heat output to site room**
- **high heat output to the buffer store**
- **combustion air independent of room air**

Source: Energieinstitut Vorarlberg

Exemplary solutions for heat production

System 4, passive house technology and biomass

Heat exchange unit (with EHE) and combination of

tiled stove with water heat exchanger

Requirements:

- **Adapted performance**
- **little heat output to site room**
- **high heat output to the buffer store**
- **combustion air independent of room air**

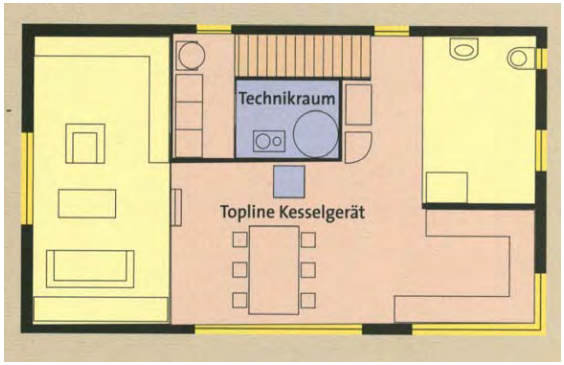
Source: M. Ploss

Exemplary solutions for heat production

System 4, passive house technology and biomass

Heat exchange unit (with EHE) and combination of

pellet-stove with water heat exchanger



Requirements:

– Adapted performance

– little heat output to site room

– high heat output to the buffer store

Recommendations:

–only in combination with large dimensioned solar system

– Position only in a big room

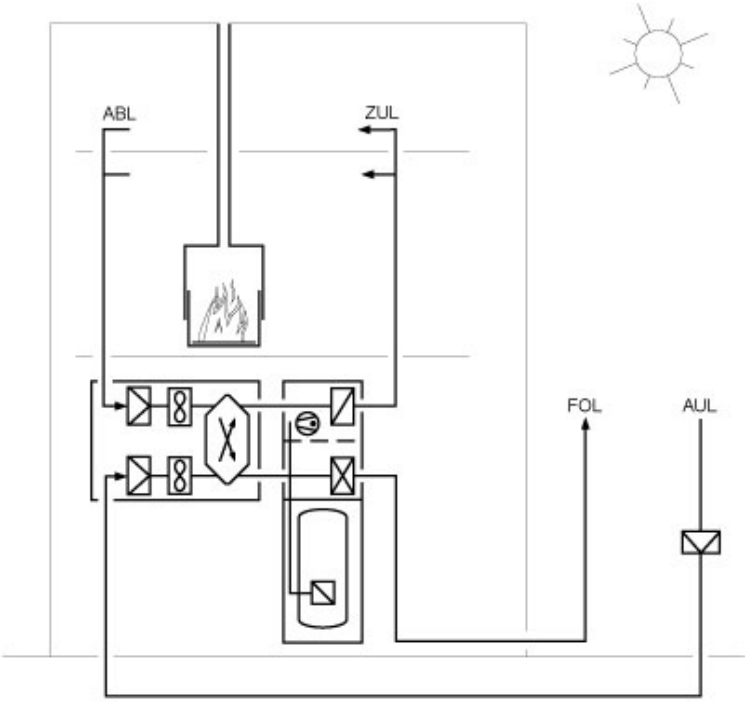
– Position near the mechanical service room with buffer store

Source: Fa. Wodke

Exemplary solutions for heat production

System 5, passive house technology and biomass

Compact unit (with EHE) and combination with pellet oven or wood stove



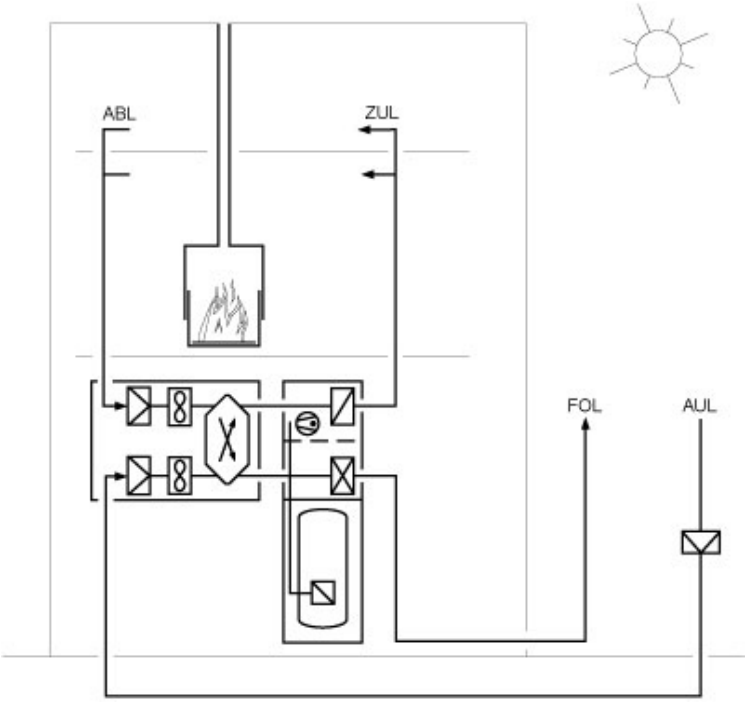
- A mini heat pump can now be eliminated by heating your building exclusively by burning pellets.
- In the passive house this system does not necessarily make sense since it is using a sledgehammer to crack a nut, so to speak. In the low energy house, however, this solution certainly does have appeal. It should be noted however that a combination with a thermal solar system here is more or less obligatory since it is necessary for hot water in the summer.

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 5, passive house technology and biomass

Compact unit (with EHE) and combination with pellet oven or wood stove



Components:

- air filter
- ventilators
- ventilation heat exchanger
- earth heat exchanger
- air/ water heat pump
- warm water storage tank
- warm water-heating radiator for input air
- wood stove

Source: www.drexel-weiss.at

Exemplary solutions for heat production

System 5, passive house technology and biomass

Compact unit (with EHE) and combination with wood stove

Requirements:

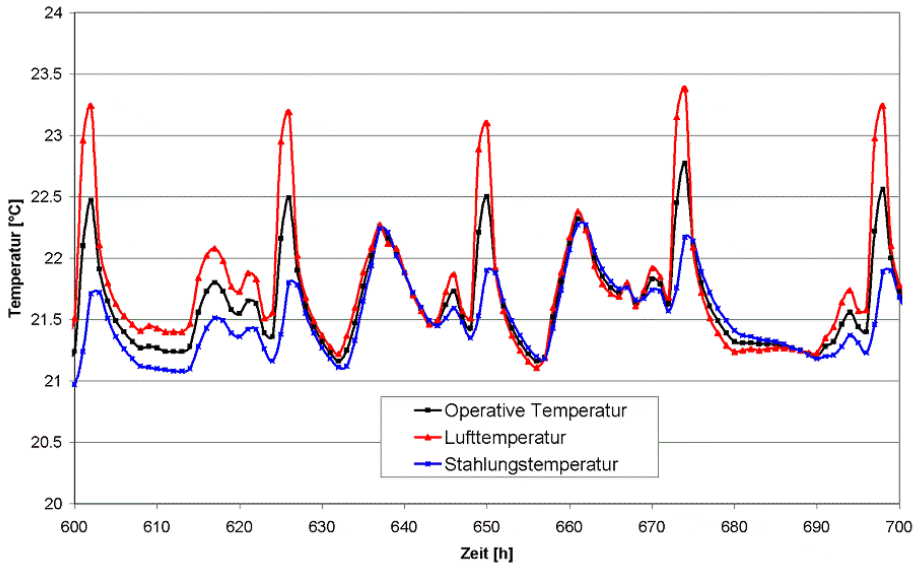
- **Adapted performance**
- **little heat output to site room**
- **high heat output to the buffer store**
- **combustion air independent of room air**

Source: Fotos: E. Heiduk, Text: www.drexel-weiss.at

Exemplary solutions for heat production

System 5, passive house technology and biomass

Compact unit (with EHE) and combination with wood stove



Such stoves offer additionally the experience of “real fire”.

The room temperature is volatile.

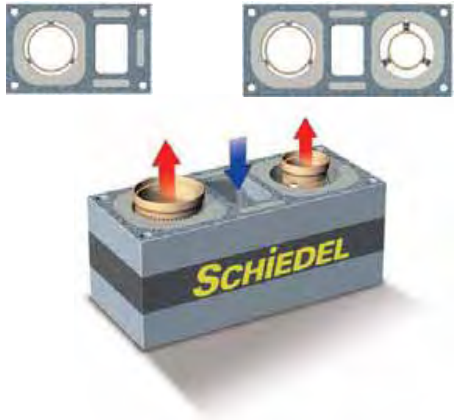
Source: http://www.passivhaustagung.de/Passivhaus_D/Passivhaus_Heizung_mit_Biomasse.html (Foto: Hase).

Exemplary solutions for heat production

System 5, passive house technology and biomass

Compact unit (with EHE) and combination with wood stove

Fireplaces are possible,
special attention must be paid to the air supply.
The best solution is a direct air supply from outside.



www.schiedel.at/fileadmin/data/austria/ABSOLUT-THERMOLUFTZUG/Thermotrennstein/Schiedel_ABSOLUT_Thermoluftzug_Internet.pdf

Source: www.trendir.com/archives/cat_fireplaces.html?start=15

Exemplary solutions for heat production

System 5, passive house technology and biomass

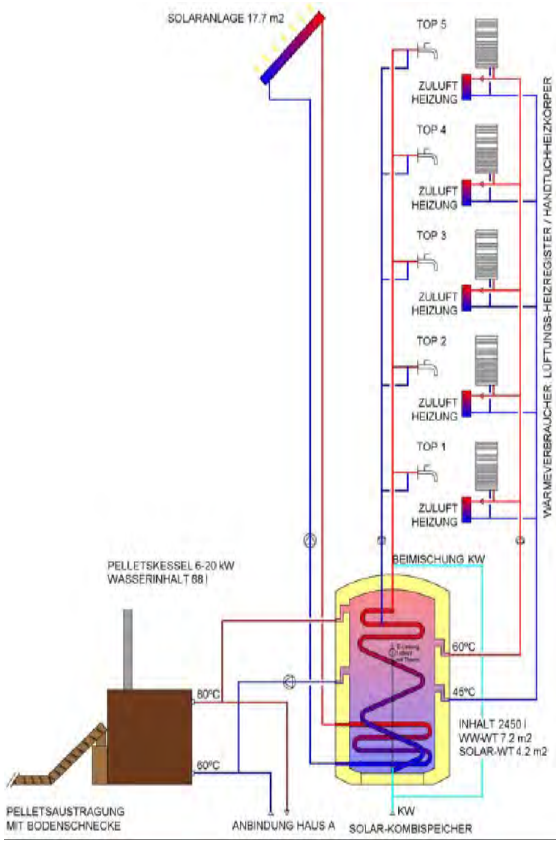
Compact unit (with EHE) and combination with alcohol stove

Balance heat producing stove (with show effect),

Run on pure alcohol, with limited use, no chimney is necessary

Source:

Exemplary solutions for heat production



Central biomass boiler
with a central solar system
in the multi-storeyed residential building

Components:

- **wood stove**
- **Solar panels**
- **Heating buffer with solar heat exchanger and with a hot water heat exchanger**
- **Hot water distribution with cold water and with circulation pipes**
- **Heat distribution with heaters and with warm water-heating register for input air**
- **hot water storage tank**

Source: CEPHEUS, PHS 1.0 Passivhaus Schulungsunterlagen 6.1.8

Exemplary solutions for heat production

System 6, passive house technology and very reduced fossil fuel

Fossil fuel as heat source

Gas fired condensing technology

– A condensing boiler (calorific value) with integrated buffer storage

– Post heating of supply air over water-air heat exchanger or heat distribution over heating panels or heating walls

Source: M. Ploss

Heat distribution in the Passive House

Significance and requirements of the heat distribution in PH

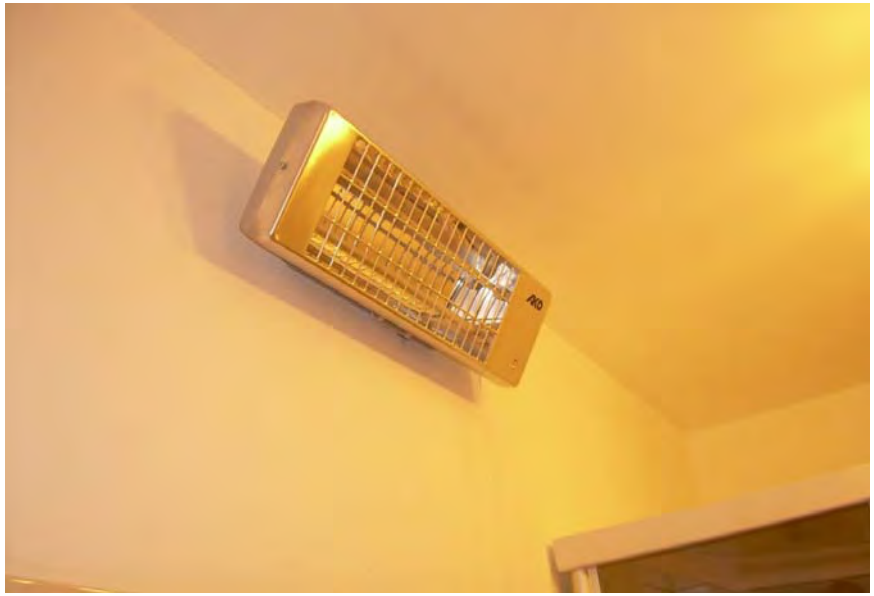
- Radiator
  - No need to be placed at the outer wall. A better position leads to lower circulation pipe lengths, lower distributing losses and more flexibility.
- Heating surface
  - Walls, ceiling and floors are suitable because of the low heating load.
- Stove/oven/furnaces
  - A large enough room for the location is necessary for circulating the heat.
- Inlet air
  - Maximum input air temperature is 50 - 55°C to avoid the toasting of dust. Input air duct must be kept strictly separate from output air duct.
- Temporary heating surface
  - Primarily in the bath, radiant heaters are used again and again. Here one should pay attention to a short-time, demand-led use.

Source: PHS 1.0 Passivhaus Schulungsunterlagen 6.2.2

Heat distribution in the Passive House

Significance and requirements of the heat distribution in PH

This comfort system is only for use in short periods only (~ 3 minutes). Direct infrared radiation at the moment of need (coming out of the shower, compensation for the cooling of the skin through evaporation). A timer would be helpful to minimize the needed power.



Source: E. Heiduk

Heat distribution in the Passive House

Dimensioning of the heat distribution in PH

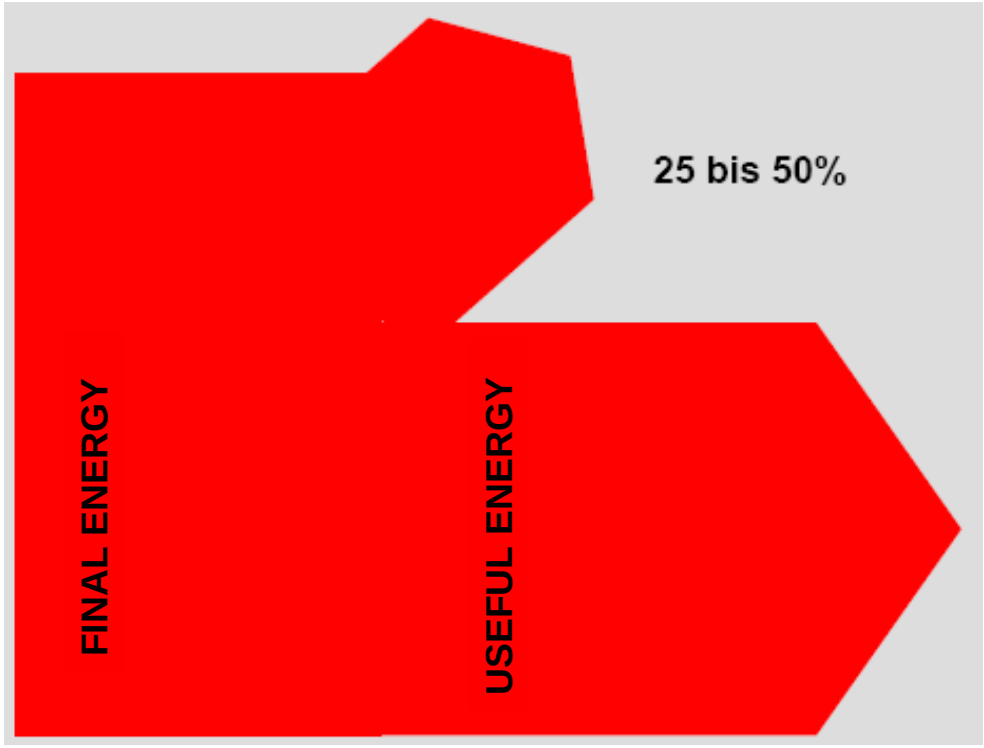
- Wall heating
  - At 40° C middle heating water temperature around 100 W/m ²
  - At 45° C middle heating water temperature around 140 W/m ²
- Floor heating
  - At 30° C middle heating water temperature around 40 W/m ²
  - At 35° C middle heating water temperature around 60 W/m ²
- Inlet air
  - Maximum capacity over the input air at 50°C input air temperature = 10 W /m²

Source: PHS 1.0 Passivhaus Schulungsunterlagen 6.2.3

Heat distribution in the Passive House

Insulation of the heat distribution

Transformation and distributing losses

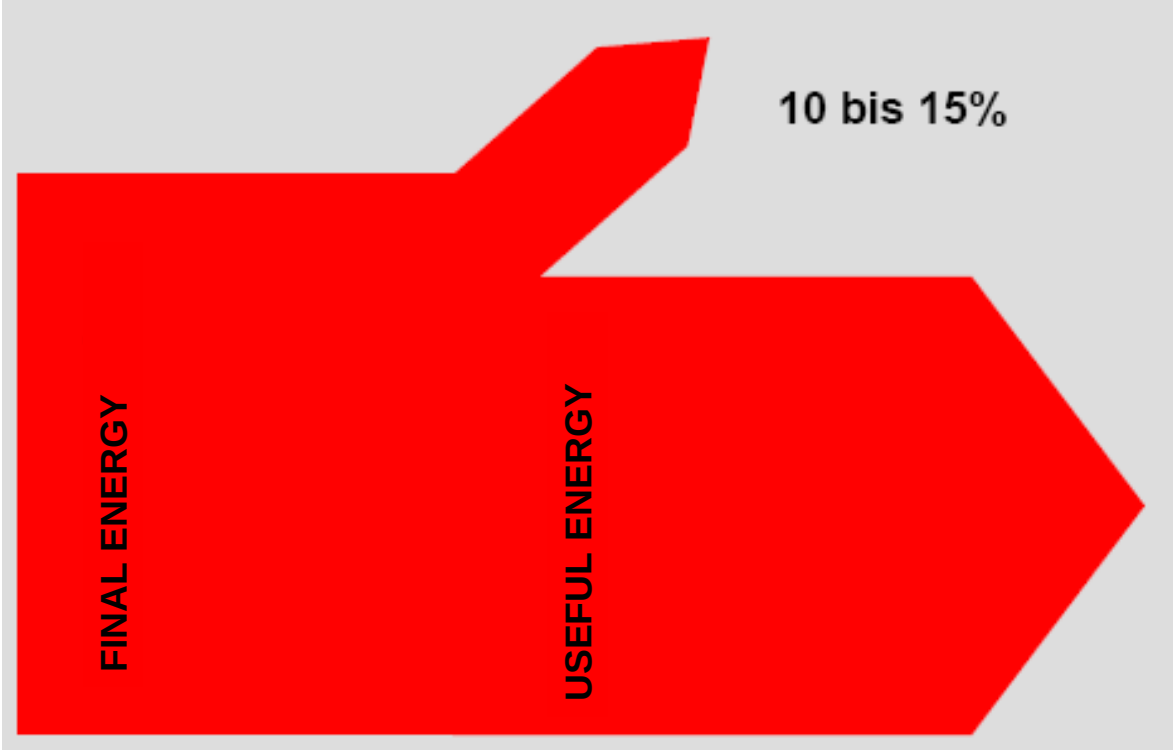


Source: Energieinstitut Vorarlberg, Krapmeier

Heat distribution in the Passive House

Insulation of the heat distribution

Transformation and distributing losses

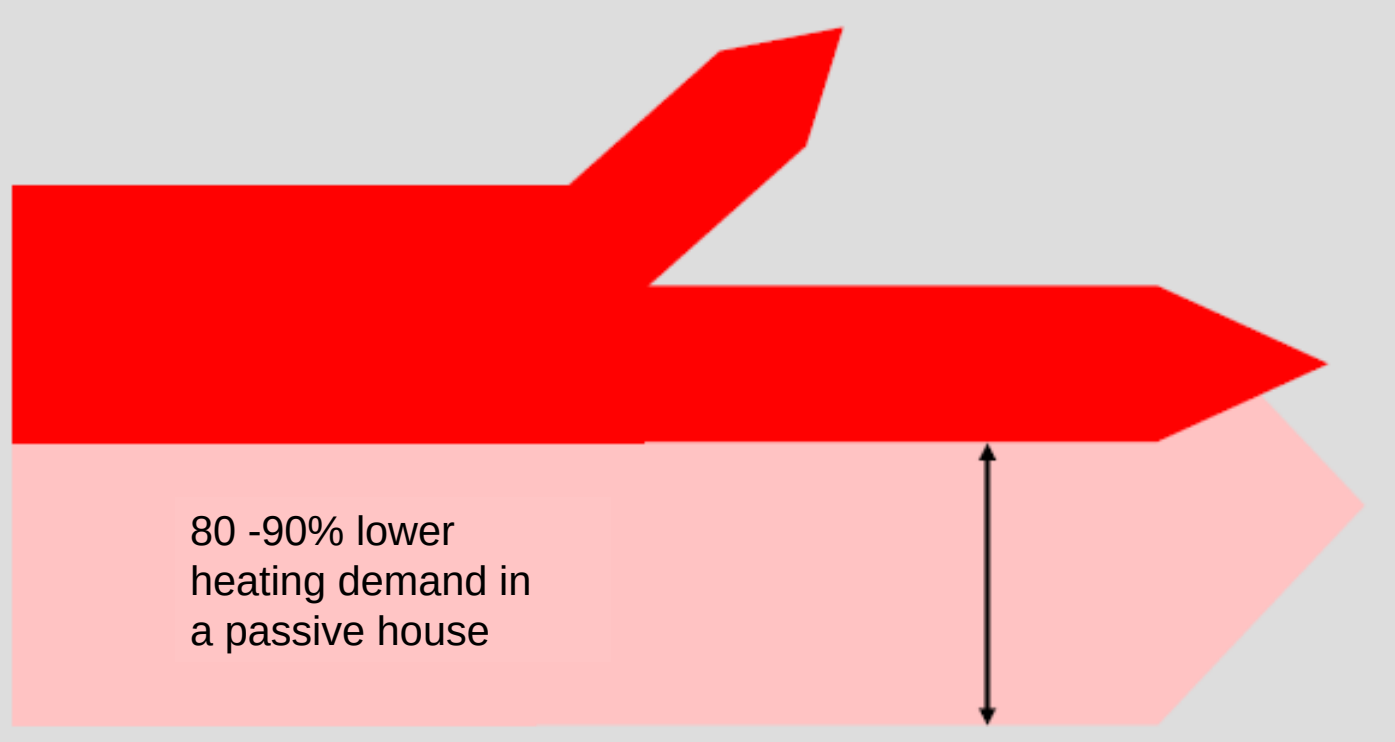


Source: Energieinstitut Vorarlberg, Krapmeier

Heat distribution in the Passive House

Insulation of the heat distribution

Transformation and distributing losses

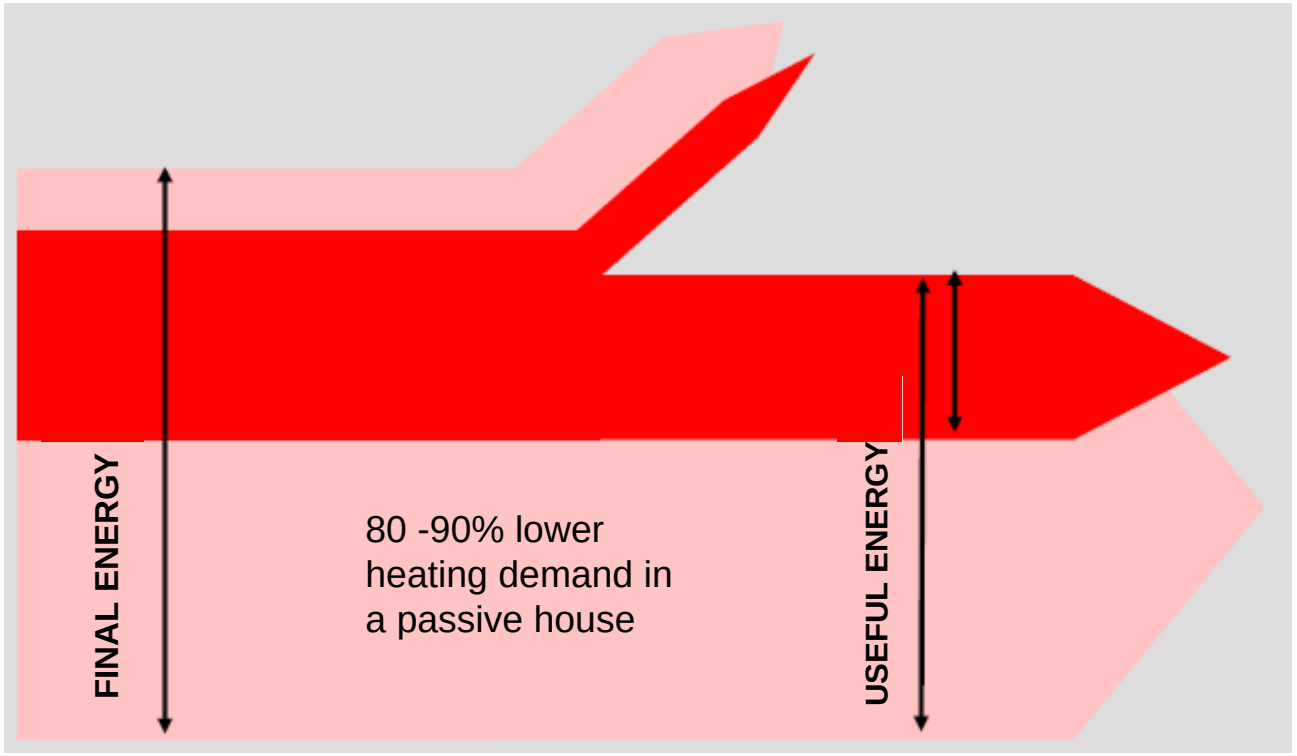


Source: Energieinstitut Vorarlberg, Krapmeier

Heat distribution in the Passive House

Insulation of the heat distribution

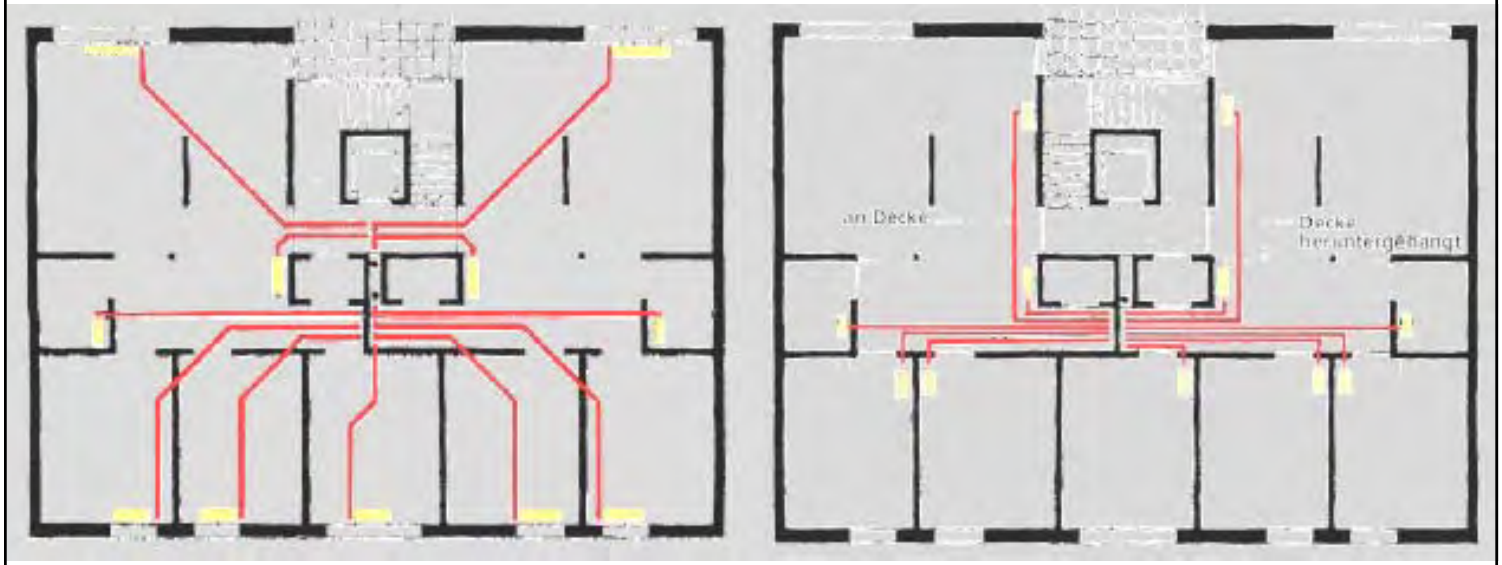
Transformation and distributing losses



Source: Energieinstitut Vorarlberg, Krapmeier

Heat distribution in the Passive House

Optimising the heat distribution



Reduction of distribution lengths

Source: Energieinstitut Vorarlberg, Krapmeier

Heat distribution in the Passive House

Quality requirements to the heat distribution in PH

- Minimising heat losses of the heat distribution
  - Insulation thickness 1 to 1.5 x pipe diameter
- Short ways for the distribution
  - Integrated planning processes to take into account the requirements on time
- Exact calculation of the heating demand
  - Calculation of the individual rooms
  - Careful dimensioning of the air quantities

Source: PHS 1.0 Passivhaus Schulungsunterlagen 6.2.10

Domestic-Hot-Water production

Heat supply

Hot-water production

Source:

Requirements for the hot water distribution

- Heat demand for warm water
  - 40 litres / person and day at 60°C or > 2,3 kWh / person and day
  - 55 litres / person and day at 45°C or > 2,2 kWh / person and day

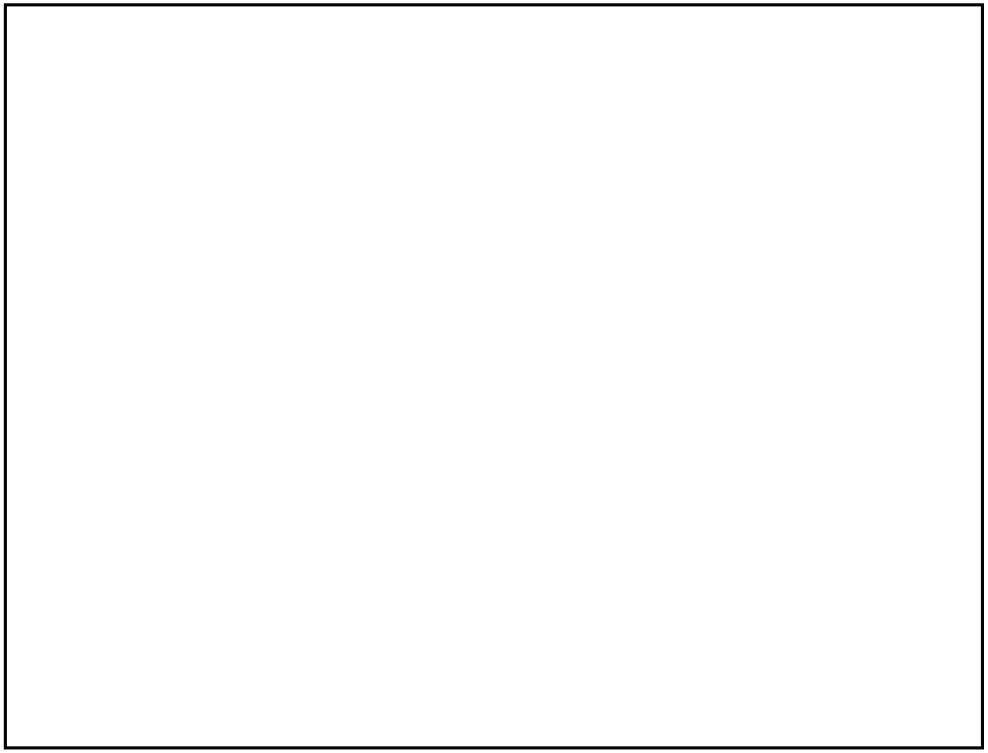
- Power demand for hot-water
  - 10 kW for heating up a boiler with 100 litres within an hour to 60°C
  - 30 kW for heating up 12 litres/ minute by a flow-through system

Source: PHS 1.0 Passivhaus Schulungsunterlagen 6.3.1

Domestic-Hot-Water production

Systems for the hot water production

Heated drinking water boiler

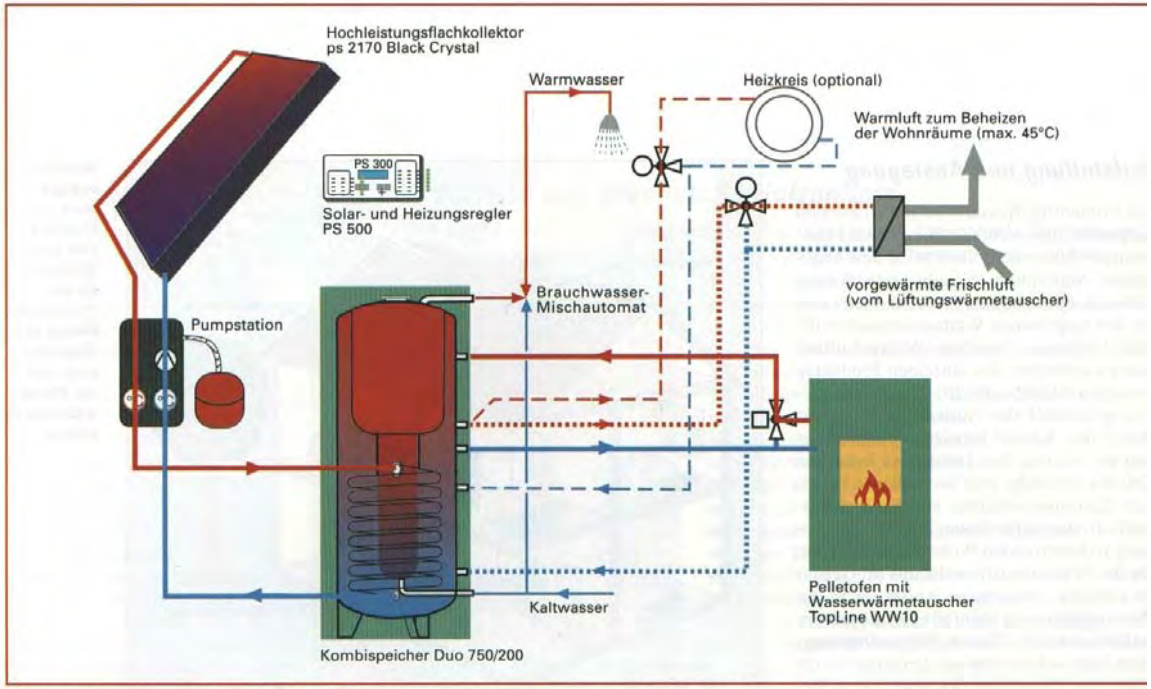


Source: Sonnenkraft

Domestic-Hot-Water production

Systems for the hot water production

Pellet-stove with water heat exchanger, a principle scheme



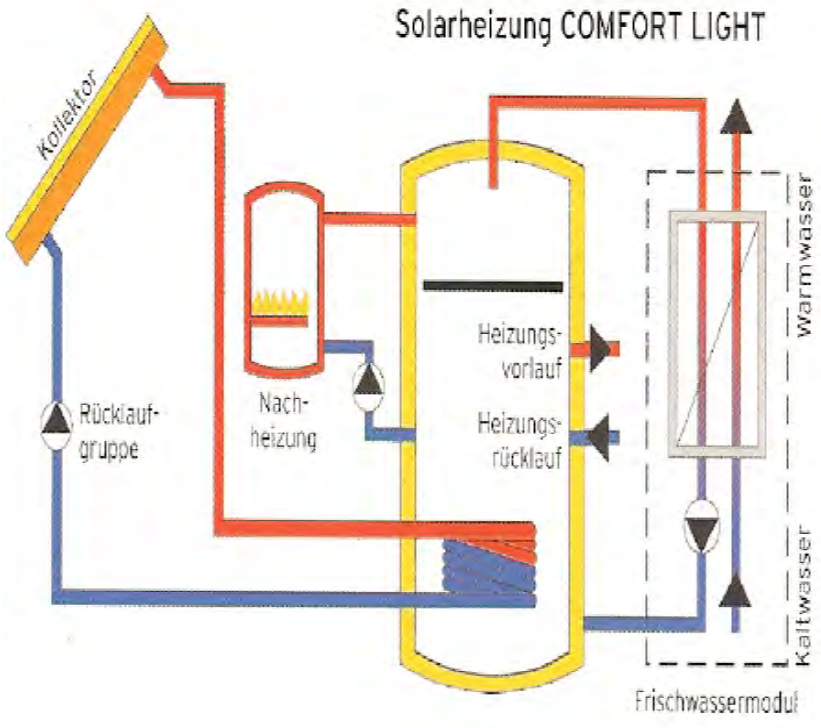
Beispielhaftes Hydraulikschema Solarsystem mit Holzpelletofen, Gesamtregelung und (optionaler) Heizkreiserweiterung

Source: Fa. Wodke

Domestic-Hot-Water production

Systems for the hot water production

Heating up drinking water in a flow-through system

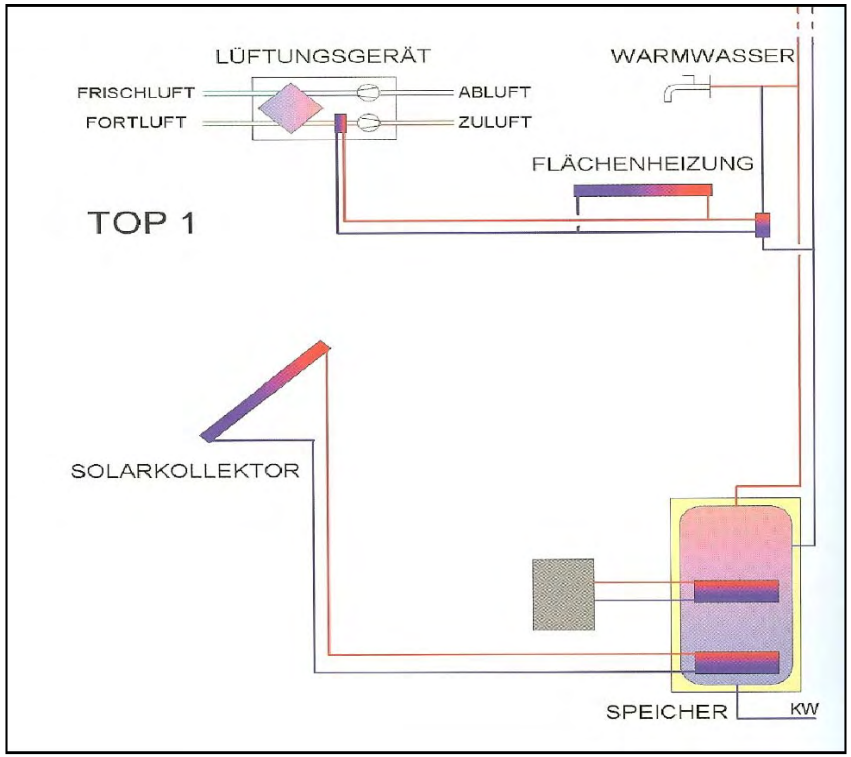


Source: Sonnenkraft

Domestic-Hot-Water production

Systems for the hot water production

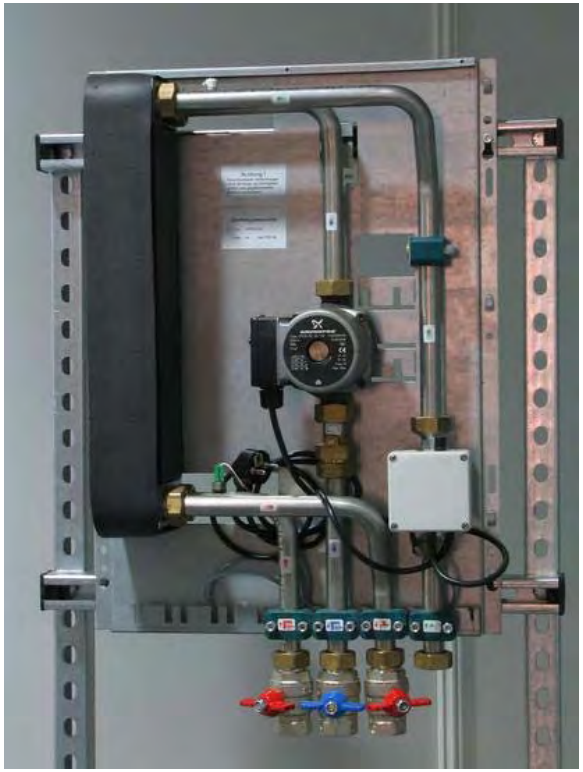
Heating up drinking water in a flow-through system



Source: Sonnenkraft

Domestic-Hot-Water production

Systems for the hot water production



- The plate heat exchanger is displaced from the heat buffer to the warm water consumer.
- Warm water is heated by the heating water.
- No industrial water storage, only the buffer storage of the heating system.
- No circulation pipe. Pipes for warm water only from the unit to the consumer.
- Warm water is generated „just in time“. There is no stored or circulated water, in which bacteria (legionella) can be cultivated.

Source: http://wohnen.pege.org/2005-weiz-sanierung/warmwasser-heizung.htm

Domestic-Hot-Water production

Systems for the hot water production

- In the multi-story buildings there is one unit per apartment.
- No warm water duct or circulation duct to the apartment is necessary.
- It is all regulated by the heating circulation system.

Source: http://wohnen.pege.org/2005-weiz-sanierung/warmwasser-heizung.htm

Dimensioning of hot water production

- Required water quantity
  - 20 – 30 litres / person and day
  - 75 – 100 litres / person if a thermo-solar system is used
- Required water boiler size
  - 20 – 30 litres / person
  - 75 – 100 litres / person if a thermo-solar system is used
- Required water boiler size for flow-through systems
  - Depends on heat production system
  - 100 litres / 1,5 m² in a flat solar-paneled thermo-solar system

Source: PHS 1.0 Passivhaus Schulungsunterlagen 6.3.5